

What is claimed is:

1. A beam splitter for producing a plurality of separated beams from a single incident beam, comprising:

5 a light transmissive member having a first surface and a second surface;

a first light-separating portion formed on the first surface; and

a second light-separating portion formed on the second surface.

10 2. The beam splitter as claimed in claim 1, wherein:

the first light-separating portion separates a portion of the single incident beam into a reflected light and a transmitted light;

15 the second light-separating portion separates a remaining portion of the single incident beam into a reflected light and a transmitted light; and

the beam splitter outputs two beams of reflected light and one beam of transmitted light.

3. The beam splitter as claimed in claim 2, wherein:

20 the light transmissive member is a transparent optical member in a shape of a triangular prism having three side surfaces; and

25 the first light-separating portion and the second light-separating portion are formed on two of the three side surfaces on the triangular prism.

4. The beam splitter as claimed in claim 3, wherein the optical member is a triangular prism having a bottom surface substantially in a shape of a right isosceles triangle.

5 5. The beam splitter as claimed in claim 1, wherein:
the light transmissive member comprises a first optical member, a second optical member, and a third optical member that are transparent triangular prisms, each of the transparent triangular prisms having:

10 a bottom surface substantially in a shape of a right isosceles triangle;

two side surfaces that include two sides that form an apex angle in the bottom surface; and

an opposing side surface that includes a side
15 opposing the apex angle in the bottom surface;

the two side surfaces of the first optical member are bonded to the opposing side surface of the second optical member and to the opposing side surface of the third optical member; and

20 the first light-separating portion and the second light-separating portion are formed on the two bonded side surfaces.

6. The beam splitter as claimed in claim 2, wherein the first and second light-separating portions have a
25 reflectance of approximately 67%.

7. The beam splitter as claimed in claim 1, wherein:

the first surface and the second surface are parallel to each other;

the first light-separating portion separates the single incident beam into a first reflected light beam and a first transmitted light beam; and

the second light-separating portion separates the first transmitted light further into a second reflected light beam and a second transmitted light beam.

8. The beam splitter as claimed in claim 7, wherein the first and second light-separating portions are formed such that the distance between the first light-separating portion and second light-separating portion along an axis parallel to the first and second surfaces is approximately $d \tan \theta$, where θ is an angle of refraction when the incident beam is incident on the first light-separating portion at an angle of approximately 45° and d is a distance between the first surface and the second surface.

9. The beam splitter as claimed in claim 7, wherein the light transmissive member further comprises a third surface and a fourth surface that sequentially transmit light transmitted through the second light-separating portion, the third surface and the fourth surface being parallel to each other and orthogonal to the first surface and the second surface.

10. The beam splitter as claimed in claim 9, wherein the distance between the first light-separating portion and the third surface along an axis parallel to the first and second surfaces is greater than $d \tan \theta$, where θ is an angle of refraction when the incident beam is incident on the first light-separating portion at an angle of approximately 45° and d is a distance between the first surface and the second surface.

11. The beam splitter as claimed in claim 9, wherein a distance between the third surface and the fourth surface is substantially equivalent to a distance between the first surface and the second surface, and an optical path of light transmitted through the fourth surface falls on an extended line passing through an optical path of the incident beam.

12. The beam splitter as claimed in claim 9, wherein the light transmissive member further comprises a fifth surface and a sixth surface that sequentially transmit light that is reflected off the first light-separating portion and subsequently reflected off a predetermined reflecting member, the fifth and sixth surfaces being parallel to each other and orthogonal to the first and second surfaces.

13. The beam splitter as claimed in claim 12, wherein a distance between the fifth and sixth surfaces is substantially equivalent to a distance between the first and second surfaces, and an optical path of light transmitted

through the sixth surface falls on an extended line passing through an optical path of light reflected off the predetermined reflecting member.

14. The beam splitter as claimed in claim 1, wherein
5 the first and second light-separating portions are formed of a light-separating film.

15. A multibeam generator comprising:
a light source generating a light beam; and
a beam splitter receiving the light beam generated by
10 the light source, including:

a light transmissive member having a first surface and a second surface;

a first light-separating portion formed on the first surface; and

15 a second light-separating portion formed on the second surface.

16. The multibeam generator as claimed in claim 15, further comprising a line-beam-generating optical element that produces a line beam from a light beam separated by at
20 least one of the first and second light-separating portions.

17. The multibeam generator as claimed in claim 16, wherein:

the beam splitter separates the light beam generated by the light source into a first reflected beam reflected by
25 the first light-separating portion, a second reflected beam

reflected by the second light-separating portion, and a transmitted beam formed of both light transmitted through the first light-separating portion and light transmitted through the second light-separating portion; and

5 the line-beam-generating optical element receives at least one of the first reflected beam, the second reflected beam, and the transmitted beam and converts the received beam to a line beam.

18. The multibeam generator as claimed in claim 17,
10 wherein:

the light transmissive member is a transparent optical member in a shape of a triangular prism having three side surfaces; and

15 the first light-separating portion and the second light-separating portion are formed on two of the three side surfaces on the triangular prism.

19. The multibeam generator as claimed in claim 18, wherein the optical member is a triangular prism having a bottom surface substantially in a shape of a right isosceles
20 triangle.

20. The multibeam generator as claimed in claim 17, wherein:

the light transmissive member comprises a first optical member, a second optical member, and a third optical
25 member that are transparent triangular prisms, each of the

transparent triangular prisms having:

a bottom surface substantially in a shape of a right isosceles triangle;

two side surfaces that include two sides that form an apex angle in the bottom surface; and

an opposing side surface that includes a side opposing the apex angle in the bottom surface;

the two side surfaces of the first optical member are bonded to the opposing side surface of the second optical member and to the opposing side surface of the third optical member; and

the first light-separating portion and the second light-separating portion are formed on the two bonded side surfaces.

21. The multibeam generator as claimed in claim 17, wherein the first and second light-separating portions have a reflectance of approximately 67%.

22. The multibeam generator as claimed in claim 15, wherein the first and second light-separating portions are formed of a light-separating film.

23. The multibeam generator as claimed in claim 15, wherein:

the first surface and the second surface are parallel to each other;

the first light-separating portion separates the

single incident beam into a first reflected light beam and a first transmitted light beam; and

the second light-separating portion separates the first transmitted light further into a second reflected
5 light beam and a second transmitted light beam.

24. The multibeam generator as claimed in claim 23, wherein:

the light transmissive member further comprises a third surface and a fourth surface that sequentially
10 transmit light transmitted through the second light-separating portion, the third surface and the fourth surface being parallel to each other and orthogonal to the first surface and the second surface;

a distance between the third surface and the fourth
15 surface is substantially equivalent to a distance between the first surface and the second surface, and an optical path of light transmitted through the fourth surface falls on an extended line passing through an optical path of the incident beam;

the light transmissive member further comprises a
20 fifth surface and a sixth surface that sequentially transmit light that is reflected off the first light-separating portion and subsequently reflected off a predetermined reflecting member, the fifth and sixth surfaces being
25 parallel to each other and orthogonal to the first and

second surfaces; and

a distance between the fifth and sixth surfaces is substantially equivalent to the distance between the first and second surfaces, and an optical path of light transmitted through the sixth surface falls on an extended line passing through an optical path of light reflected off the predetermined reflecting member.

25. A line-beam-generating optical system comprising:

a light source generating a laser beam;

a collimating lens converting light emitted from the light source into collimated light;

a triangular prism having three side surfaces, a first side surface and a second side surface of the three side surfaces forming an apex angle, a first light-separating portion being formed on the first surface and a second light-separating portion being formed on the second surface, the triangular prism receiving the collimated light at the apex angle and separating the collimated light into four light beams; and

a line-beam-generating optical element disposed on at least one optical path of the four light beams emitted from the triangular prism for converting at least one light beam into at least one line beam.

26. The line-beam-generating optical system as claimed in claim 25, further comprising:

a reflecting mirror provided between the triangular prism and the line-beam-generating optical element, the reflecting mirror reflecting the light beam emitted from the triangular prism to change an optical path of the light beam.

5 27. The line-beam-generating optical system as claimed in claim 25, wherein the light source has a laser emitting surface that emits laser light, and the apex angle of the triangular prism confronts the laser emitting surface.

10 28. The line-beam-generating optical system as claimed in claim 25, further comprising an optical element converting a cross-sectional beam shape of the collimated light formed by the collimating lens into a substantially circular shape.

15 29. The line-beam-generating optical system as claimed in claim 28, wherein the optical element comprises an anamorphic lens that changes a circularity of the collimated light.

20 30. The line-beam-generating optical system as claimed in claim 25, further comprising a dove prism located between the triangular prism and the line-beam-generating optical element, the dove prism rotating a cross-sectional shape of the light beam.

25 31. The line-beam-generating optical system as claimed in claim 25, wherein each of the first and second light-separating portions are formed of a light-separating film.

32. A laser marking apparatus comprising:

a laser generating a light beam;

a beam splitter receiving the light beam generated by the laser, including:

5 a light transmissive member having a first surface and a second surface;

a first light-separating portion formed on the first surface; and

10 a second light-separating portion formed on the second surface;

a line-beam-generating optical element generating a line beam from a light beam separated by at least one of the first and second light-separating portions; and

15 a support unit supporting the laser, the beam splitter, and the line-beam-generating optical element.

33. The laser marking apparatus as claimed in claim 32, wherein:

20 the beam splitter separates the light beam generated by the laser into a first reflected beam reflected by the first light-separating portion, a second reflected beam reflected by the second light-separating portion, and a transmitted beam formed of both light transmitted through the first light-separating portion and light transmitted through the second light-separating portion; and

25 the line-beam-generating optical element receives at

least one of the first reflected beam, the second reflected beam, and the transmitted beam and converts the received beam to a line beam.

34. The laser marking apparatus as claimed in claim 32,
5 further comprising:

a light-separating element provided along a path of at least one of the light reflected off the first light-separating portion, the light reflected off the second light-separating portion, and the light transmitted through
10 the first and second light-separating portions, thereby generating at least four light beams;

the line-beam-generating optical element receiving at least one of the at least four light beams and converting the light beams to line beams.

15 35. The laser marking apparatus as claimed in claim 33, wherein:

the light transmissive member is a transparent optical member in a shape of a triangular prism having three side surfaces; and

20 the first light-separating portion and the second light-separating portion are formed on two of the three side surfaces on the triangular prism.

36. The laser marking apparatus as claimed in claim 35, wherein the optical member is a triangular prism having a
25 bottom surface substantially in a shape of a right isosceles

triangle.

37. The laser marking apparatus as claimed in claim 33, wherein:

the light transmissive member comprises a first
5 optical member, a second optical member, and a third optical member that are transparent triangular prisms, each of the transparent triangular prisms having:

a bottom surface substantially in a shape of a right isosceles triangle;

10 two side surfaces that include two sides that form an apex angle in the bottom surface; and

an opposing side surface that includes a side opposing the apex angle in the bottom surface;

the two side surfaces of the first optical member are
15 bonded to the opposing side surface of the second optical member and to the opposing side surface of the third optical member; and

the first light-separating portion and the second light-separating portion are formed on the two bonded side
20 surfaces.

38. The laser marking apparatus as claimed in claim 33, wherein the first and second light-separating portions have a reflectance of approximately 67%.

39. The laser marking apparatus as claimed in claim 33,
25 further comprising a collimating lens disposed between the

laser and the beam splitter for converting light emitted from the laser into collimated light;

the light transmissive member being formed of a triangular prism having three side surfaces, a first side surface and a second side surface of the three side surfaces forming an apex angle, a third side surface of the three side surfaces opposing the apex angle, a first light-separating portion being formed on the first surface and a second light-separating portion being formed on the second surface, the triangular prism receiving the collimated light at the apex angle and separating the collimated light into four light beams in cooperation with the first and second light-separating portions.

40. The laser marking apparatus as claimed in claim 39, wherein the triangular prism emits a first light beam and a second light beam from the third side surface, emits a third light beam from the first side surface, and emits a fourth light beam from the second side surface;

the laser marking apparatus further comprising:

a first line-beam-generating optical element disposed along an optical path of the first light beam for converting the first light beam into a line beam; and

a second line-beam-generating optical element disposed along an optical path of the second light beam for converting the second light beam into a line beam.

41. The laser marking apparatus as claimed in claim 40,
wherein the first and second light-separating portions emit
the third and fourth light beams in a direction
substantially perpendicular to an incidence direction of the
5 collimated light.

42. The laser marking apparatus as claimed in claim 40,
further comprising an optical path changing element disposed
along at least one of the optical paths of the first and
second light beams, the optical path changing element
10 converting at least one of the optical paths so that light
travels in a horizontal direction.

43. The laser marking apparatus as claimed in claim 42,
wherein:

the optical path changing element is disposed along
15 the optical path of the first light beam and converts the
optical path of the first light beam so that the first light
beam travels in a horizontal direction;

the first line-beam-generating optical element is
provided for receiving the first light beam from the optical
20 path changing element and generates a horizontal line beam
from the first light beam; and

the second line-beam-generating optical element
generates a vertical line beam from the second light beam.

44. The laser marking apparatus as claimed in claim 40,
25 further comprising a dove prism disposed between the

triangular prism and the line-beam-generating optical element along at least one of the optical paths of the first and second light beams, the dove prism rotating a cross-sectional beam shape of at least one of the first and second
5 light beams.

45. The laser marking apparatus as claimed in claim 40, further comprising an optical element disposed along an optical path between the collimating lens and the triangular prism, the optical element changing a cross-sectional shape
10 of a light beam to a substantially circular shape.

46. The laser marking apparatus as claimed in claim 39, further comprising a reflecting mirror provided along an optical path of at least one light beam emitted from the triangular prism, the reflecting mirror modifying the
15 optical path of the light beam.

47. The laser marking apparatus as claimed in claim 39, wherein the laser has a laser emitting surface that emits laser light, and the apex angle of the triangular prism confronts the laser emitting surface.

48. The laser marking apparatus as claimed in claim 39, further comprising an optical element converting a cross-sectional beam shape of the collimated light formed by the collimating lens into a substantially circular shape.
20

49. The laser marking apparatus as claimed in claim 48,
25 wherein the optical element comprises an anamorphic lens

that changes a circularity of the collimated light.

50. The laser marking apparatus as claimed in claim 39, further comprising a dove prism provided along an optical path of at least one of four light beams emitted from the triangular prism, the dove prism rotating a cross-sectional beam shape of the at least one of four light beams.

51. The laser marking apparatus as claimed in claim 32, wherein:

the first surface and the second surface are parallel to each other;

the first light-separating portion separates the single incident beam into a first reflected light beam and a first transmitted light beam; and

the second light-separating portion separates the first transmitted light further into a second reflected light beam and a second transmitted light beam.

52. The laser marking apparatus as claimed in claim 51, wherein the first and second light-separating portions are formed such that the distance between the first light-separating portion and second light-separating portion along an axis parallel to the first and second surfaces is approximately $d \tan \theta$, where θ is an angle of refraction when the incident beam is incident on the first light-separating portion at an angle of approximately 45° and d is a distance between the first surface and the second surface.

53. The laser marking apparatus as claimed in claim 51,
wherein the light transmissive member further comprises a
third surface and a fourth surface that sequentially
transmit light transmitted through the second light-
separating portion, the third surface and the fourth surface
being parallel to each other and orthogonal to the first
surface and the second surface.

54. The laser marking apparatus as claimed in claim 53,
wherein the distance between the first light-separating
portion and the third surface along an axis parallel to the
first and second surfaces is greater than $d \tan \theta$, where θ is
an angle of refraction when the incident beam is incident on
the first light-separating portion at an angle of
approximately 45° and d is a distance between the first
surface and the second surface.

55. The laser marking apparatus as claimed in claim 53,
wherein a distance between the third surface and the fourth
surface is substantially equivalent to a distance between
the first surface and the second surface, and an optical
path of light transmitted through the fourth surface falls
on an extended line passing through an optical path of the
incident beam.

56. The laser marking apparatus as claimed in claim 53,
wherein the light transmissive member further comprises a
fifth surface and a sixth surface that sequentially transmit

light that is reflected off the first light-separating portion and subsequently reflected off a predetermined reflecting member, the fifth and sixth surfaces being parallel to each other and orthogonal to the first and second surfaces.

57. The laser marking apparatus as claimed in claim 56, wherein a distance between the fifth and sixth surfaces is substantially equivalent to a distance between the first and second surfaces, and an optical path of light transmitted through the sixth surface falls on an extended line passing through an optical path of light reflected off the predetermined reflecting member.

58. The laser marking apparatus as claimed in claim 32, wherein the first and second light-separating portions are formed of a light-separating film.